METHOD AND ASSEMBLY FOR EVALUATING THE STATE OF CHARGE OF BATTERIES

FIELD OF THE INVENTION

[001] The invention relates to the field of battery evaluation. More specifically, it relates to methods and assemblies for determining the state of charge of one or more batteries without disturbing the surrounding environment of the batteries.

BACKGROUND OF THE INVENTION

[002] Battery-operated electrical devices are very common, and in many situations it is desirable to determine the state of charge of the batteries before they are used to provide power to a device. It is also desirable that this determination be made as quickly and easily as possible. The need to assess the state of charge can be especially crucial in situations where a battery has been idle for an extended time period but must then reliably supply power at any given moment. In such situations recharging or replacing defective batteries alone may be too time consuming or even impossible, and replacing an entire electronic or electrical assembly is the only feasible remedy, once the battery state of charge is quickly determined. A quick and easy method of battery testing would be beneficial in such areas as emergency equipment, military equipment, and avionics.

[003] As one example, flashlights and batteries to power them are often kept in storage for use during a power outage or other emergency. A supply of charged batteries must be immediately available at all times. An easy way to monitor the state of charge of such stored batteries is clearly essential.

[004] Another example is an alarm system that must be put into service immediately upon installation. It would be highly desirable for full battery capacity to be available to provide full functionality of the alarm system without waiting for the batteries to become charged.

[005] As another example, quality control of battery-operated devices would be facilitated by a convenient battery evaluation. A charged battery may gradually become discharged while on an assembly line, after sitting for a long time in a warehouse, or after being delivered to a customer. A simple way to check the state of charge of the battery would benefit the manufacturer and purchaser alike.

[006] U.S. Patent 3,454,873, granted to Abrahams discloses a very simple battery test device using a small light bulb as indicator. Although simple and convenient, this device provides only a crude, qualitative indication of the state of charge, not sufficient for the applications described above.

[007] A battery tester is often included in the packaging of AA or 9-volt batteries. One attaches the positive and negative battery terminals to the tester and a colored display indicates whether the battery is fully charged, partially charged, or only minimally charged. These battery testers are typically rather complex multilayer flat structures incorporating a thermochromic or electrochromic material, one which changes color in response to heat or electric fields, respectively. Such testers are disclosed in U.S. Patents 5,223,003; 5,389,458; and 5,418,085; U.S. Patent Application Publication US/0049522; and EP Application Publication 0 495 636 A2.

[008] Another class of battery testers makes use of a separate electrochemical or electrolytic cell, as disclosed in U.S. Patents 5,627,472 and 5,596,278. However, the need for an extra cell makes such testers relatively complex and costly.

[009] U.S. Patent 6,291,096 B1 discloses a relatively simple tester that continuously displays the state of charge of a battery, with no action required by the user. While offering convenience, this device must continuously draw a small current from the battery, which could discharge the battery over a prolonged idle period.

[0010] There is thus a need for a simple, quick, and inexpensive method and apparatus for assessing the state of charge of batteries prior to use. For greatest convenience, one should be able to assess the batteries without disturbing them or removing them from their packaging or from a device in which they are installed.

BRIEF DESCRIPTION OF THE INVENTION

[0011] The invention comprises a method and assembly for quickly and easily evaluating the state of charge of at least one battery without disturbing the batteries. In one embodiment, the batteries are physically installed in a battery-operated device, but the battery terminals are electrically insulated from contact areas of the device by insulating material between the terminals and the contact areas. The purpose of this insulating is to minimize loss of battery charge before the device is put into operation. At the same time, positive and negative battery terminals are each in electrical contact with an electrical conductor, and these conductors extend outward from the battery-operated device. This enables a user to bring the battery terminals into electrical contact with a measuring device, such as a voltmeter, and thereby determine the state of charge of the battery or batteries. If the state of charge is determined to be acceptable, the insulating material may then be removed, bringing the battery terminals into electrical contact with the contact areas of the battery-powered device,

thereby activating the device. If the state of charge is found to be unacceptable, the battery may be recharged or replaced or the entire assembly of battery and battery-operated device may be replaced and the state of charge measured again.

[0012] In another embodiment, the batteries, with or without a battery-operated device, are either partially or fully enclosed in such a way that direct physical contact with the actual terminals of the batteries is not possible. Conductors, connected to battery terminals at one end, extend to the outside of the enclosure, thereby allowing one to determine the state of charge of the batteries by attaching a measuring device to the conductors outside the enclosure. An example of this embodiment is batteries enclosed in a package, with the conductors extending to the outside of the package.

BRIEF DESCRIPTION OF THE FIGURES

[0013] Figure 1 is an exploded view showing a battery, conductors, device contact areas, and a measuring device displaying the state of charge of the battery.

[0014] Figure 2 is an overall view of one embodiment of the invention, showing a battery with attached conductors and a battery-powered device.

[0015] Figure 3 shows another embodiment of the invention, a package enclosing a battery with the conductors and test points on the outside of the package.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Figure 1 is an exploded view illustrating an assembly as an embodiment of the invention. A battery **11** has two terminals **20**, one positive and one negative. The terminals make electrical contact with two conductors **13** as indicated by the dashed arrows. The battery terminals **20** are electrically insulated from device contact areas

22 which are connected by wires **15** and **16** to a battery-operated device (not shown). This insulation is achieved by electrically insulating material **12** situated underneath the conductors **13**. The state of charge of the battery is determined by bringing the probes **28** of a measuring device **24** into electrical contact with the conductors **13** at the test points indicated by the targets **14**. The battery state of charge is displayed by lights **26** on the face of the measuring device **24**.

[0017] Once the state of charge is determined, the battery-operated device may be activated by removing the conductors **13** and insulator **12** by pulling in the direction of the solid arrow. Once this is done the battery terminals **20** will be in electrical contact with the device contact areas **22** and power from the battery will be conveyed to the battery-powered device through the wires **15** and **16** connected to the device contact areas **22**.

[0018] Alternatively, the conductors **13** could be sandwiched between two layers of insulting material. In this case the layer indicated by **12** in Figure 1 becomes a bottom insulating layer, and an additional top insulating layer is placed over the conducting stripes **13** to provide additional protection against accidentally short-circuiting the battery. A portion of this top layer may be removed at the end nearest the battery terminals **20** to allow the terminals **20** to come into electrical contact with the conductors **13**.

[0019] In one embodiment the insulating material **12** and the conductors **13** are integrated into a single unit in the form of a flat flexible ribbon. The insulating material **12** must withstand the voltage of the battery **11** without breakdown and without allowing leakage currents to flow. It should also have a slippery quality, allowing it to be easily removed by sliding. It must also have sufficient mechanical

integrity so as not to be punctured, torn, or otherwise penetrated by the battery terminals **20** or device contact areas **22**. Suitable materials for the insulator **12** include, but are not limited to, bonded spun polymeric material such as those known by the trademark TYVEK ®; polymeric paper, pressboard, nonwoven materials, and film materials, such as those known by the trademarks TEFLON ®, KAPTON ®, MYLAR ®, KYNAR ®, and NOMEX ®; or paper coated with a wax or a resin.

[0020] Also in this embodiment, the conductors **13** are in the form of thin film-like stripes of conducting material, providing connections between the battery terminals and the measuring device. Preferably, these stripes may be fabricated on the insulating material by a process such as, but not limited to, painting, spraying, printing, or silk-screen printing. Suitable materials for the conducting stripes include, but are not limited to, carbon ink, thin carbon films, and conductive epoxies.

[0021] In another embodiment the resistance of the stripes **13** is relatively high and the measuring device **24** is a high-impedance voltmeter which measures the open-circuit voltage of the battery **11**. An advantage of using such high-impedance conductors is that very little current is drawn from the battery during the test. A further advantage is that the high resistance of the stripes **13** will limit the current drawn from the battery **11**, thereby preventing damage to the battery in the event that the conductors **13** are bridged or "shorted" by highly conducting material. Alternatively, at least one of the conductors **13** could be in series with a resistance high enough to prevent damage to the battery by limiting the current in the event the conductors are bridged. Alternatively, at least one of the conductors **13** could be in series with a fuse, which is designed to open in the event the conductors are bridged, thereby protecting the battery.

[0022] In other embodiments, the measuring device **24** could be an ammeter for measuring current, a thermochromic, electrochromic, or electrophoretic device, or an electrochemical cell or an electrolytic cell.

[0023] Figure 2 shows an overall view of an exemplary embodiment of the invention, an example of an asset-tracking device. This embodiment of the invention is incorporated in a unit, which is mounted on a mobile trailer. The unit determines and communicates the location of the mobile trailer by making use of the Global Positioning System (GPS) and low-earth-orbit communication satellites. A battery **11** is mounted next to a battery-operated device **10**, in this case an integrated GPS detector and satellite transceiver. Two conducting stripes **13** make contact with the battery terminals (not visible) and extend beyond the edge of the assembly. The conducting stripes are integral with a strip of electrically insulating material **12**. At the end of each conductor is a test target **14**, indicating where the probes of a measuring device are to be placed in order to determine the state of charge of the battery. If the state of charge is found to be acceptable, the unit is attached to the trailer and the device **10** is activated. Activation is achieved by removing the integrated insulating strip **12** and conductors **13** in the direction of the arrow, thereby allowing electrical contact between the terminals (not shown) of the battery **11** and device contact areas (not shown). The battery **10** then supplies power to the device **10** through wires **15** and **16**.

[0024] Figure 3 shows another exemplary embodiment of the invention, a package **30**, containing a battery (not shown) either alone or with a battery-operated device. This embodiment enables the state of charge of the battery to be determined without opening the package **30**, since the conductors **13** and test points **14** are on the

outside of the package **30**. This is especially helpful for quality control in manufacturing and shipping. The state of charge of the battery could be checked before packaging, just before shipping (perhaps after sitting for a long time in a warehouse), and upon receipt by the end user. In particular, testing on an assembly line or elsewhere could be automated for batteries packaged according to this embodiment.

[0025] In this embodiment, the conducting stripes **13** are connected to the battery terminals at one end (not shown) and the stripes **13** extend to and terminate on the outside of the package **30**. The state of charge of the battery may be determined by placing the probes of a measuring device on the two test point targets **14**. The battery terminals are electrically isolated from each other and from other conductors by the insulating material **12**.

[0026] If the state of charge is found unacceptable the package may be returned to the vendor unopened, thereby avoiding time and costs associated with repackaging and with replacing the battery after it is installed.

[0027] It is to be understood that the descriptions and embodiments described above are exemplary, and are not to be taken as limiting the scope of the invention. Alternatives, modifications, and variations, which do not depart from the spirit and scope of this invention, will be apparent to those skilled in the art. The scope of this invention is to be defined by the following claims: